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ANNIVERSARY
LECTURE SERIES
University of Illinois
Graduate College

REQUISITES FOR SURVIVAL

By Harrison Brown

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By Harrison Brown
Professor of Geochemistry
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FIFTIETH ANNIVERSARY OF THE GRADUATE COLLEGE AT THE UNIVERSITY OF ILLINOIS

This year the University of Illinois is celebrating the Fiftieth Anniversary of the formal opening of its Graduate School, which was inaugurated in 1908. There had been graduate instruction prior to that date, but the work was conducted by the individual departments without uniformity of aims and standards. The first graduate students were enrolled in 1874, and by 1903 the graduate population comprised 3 per cent of the total enrollment. Only master's degrees were awarded at first, but in 1903 the first two candidates for the doctorate received their degrees.

By 1906 the need for an expanded graduate program became apparent and President Edmund J. James appointed a "Committee of the Graduate School." This Committee drew up plans which culminated in the formal opening of the Graduate School in February, 1908, under Dean David Kinley, who was later to become President of the University.

Starting with an enrollment of 168 students receiving graduate instruction in 12 departments, the School expanded to the point where more than 3,500 students are now enrolled in over 65 departments.

In 1947 the name of the School was changed to the Graduate College to reflect its size and breadth of interest. Besides administering programs of advanced study, the College supports a number of interdisciplinary enterprises, such as the Digital Computer Laboratory, and administers the University's fellowship and graduate scholarship programs. Drawing its students from all over the country and, indeed, the world, the Graduate College has become a true community of scholars.

FREDERICK T. WALL, *Dean*
Graduate College

LECTURES IN COMMEMORATION OF THE FIFTIETH ANNIVERSARY OF THE GRADUATE COLLEGE

I. THE UNIVERSITY OF ILLINOIS IN RETROSPECT

Mark Van Doren
Professor of English, Columbia University
January 26, 1958

II. THE WORLD VIEW OF MODERNS

Hermann J. Muller
Distinguished Service Professor of Zoology, Indiana University
February 11, 1958

III. REQUISITES FOR SURVIVAL

Harrison Brown
Professor of Geochemistry, California Institute of Technology
March 13, 1958

IV. THE AMERICAN ARTS AND AMERICAN FREEDOM: A WORLD VIEW

Allan Nevins
Professor of American History, Columbia University
April 8, 1958

V. UNCONSCIOUS PROCESSES AND MAN'S RATIONALITY

Ernest R. Hilgard
Professor of Psychology, Stanford University
May 7, 1958

Copies of these lectures may be procured from the University of Illinois Press

REQUISITES FOR SURVIVAL

By Harrison Brown

It is an honor and a pleasure for me to be with you this evening for the dual purpose of delivering the annual James Lecture in government and of helping you celebrate the Golden Anniversary of the Graduate College of the University of Illinois.

1.

We are confronted today by the very basic elementary problem of survival — survival of our nation, our freedom, our culture, our people, our civilization and of the human species itself. But our problem today differs considerably from that of Neanderthal Man when suddenly confronted by a wild beast. Then the decision was a very simple one — kill or be killed. But now, so complex has our modern industrial world become, and so dependent have we become upon the smooth functioning of the intricate network of mines and factories for our continued existence, the problem of survival has been transformed into a fantastic assortment of problems — all of which are interrelated and all of which must be recognized and solved if human beings are to continue to inhabit the earth.

The days of Neanderthal simplicity are gone. Yet with monotonous regularity we in the United States attempt to reduce our problems to Stone Age primitiveness. We search for simple answers in a world which unfortunately presents us only with complex problems.

At the moment we are confronted by what is called the Soviet threat — the Soviet Union has become to us what the beast was to Neanderthal Man. Our addiction to oversimplification has led us to justify practically everything we do or don't do on the basis of what the Soviet Union does or does not do. I would like to stress at the outset that I believe this to be an extremely dangerous attitude. The dangers which are inherent in the present deadlock between the United States and the Soviet Union are, of course, enormous. But we should not permit our concern with the Soviet Union to cause us to ignore the other serious threats which we face.

I have had the good fortune of being invited to deliver two lectures this week, one in Minneapolis[1] and the other here in Urbana. I say "good fortune" because there are many things I want to say about the problems of survival — indeed, far more than I can say in a single lecture. In Minneapolis I confined my remarks primarily to a discussion of the possible consequences of our present policies with respect to the Soviet Union and I placed primary emphasis upon our attitudes toward nuclear weapons. In my lecture tonight I would like to place primary emphasis upon the problems which confront us outside the area of military technology — problems which are not quite so obvious, yet which are, I believe, fully as critical for us as a nation and as members of the community of mankind.

In our modern scientific-technological world it is, of course, impossible to divorce completely the problems of military technology and disarmament from the other problems which face us — all are interrelated and they cannot in the long run be solved separately. Therefore although I am going to speak tonight primarily about problems of a non-military nature, I would like to spend the first few moments outlining some of my views concerning our present policies with respect to nuclear weapons.

Our present policies are apparently based upon several premises:

First, it is assumed that a strong strategic nuclear striking power, sufficient to destroy any nation which might strike at us, represents the most reliable deterrent to the outbreak of a large-scale nuclear war.

Second, it is assumed that our nuclear striking power will not remain adequate, particularly in the new age of missiles, unless we maintain a vigorous program of nuclear weapon development aimed at devising a variety of weapons ranging from intercontinental anti-aircraft and anti-missile devices of various kinds.

Third, it is assumed that we will, at least for many decades ahead, be confronted by "little" wars and that we must be prepared to fight these wars, using nuclear tactical weapons, in such a way that the little wars do not become big ones. In this connection it is taken for granted, but seldom explicitly stated, that it is considerably less expensive to achieve a given level of tactical military power using nuclear weapons than to achieve the same level of power using ordinary explosives.

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[1] The Gideon Seymour Memorial Lecture, University of Minnesota, March 9, 1958.

Fourth, it is assumed that nuclear disarmament and, associated with it, a cessation of nuclear tests, is impossible because one could not be certain that tests were not being conducted by a potential enemy in secret.

In answer to the criticism that the testing of nuclear devices causes the deaths of a substantial number of human beings each year as a result of radioactive fallout, the proponents of our present policies argue that the resultant deaths are few in number when compared with the deaths which occur each year from natural causes. They argue further that we must balance, against these deaths, the consequences of our failure to maintain a vigorous nuclear weapons development program.

I believe that our present policies with respect to nuclear weapons are wrong, in part because I believe the premises are in large measure wrong and in part because the premises do not take into account the technological evolution which will in all likelihood take place in the world during the course of the next few decades. I also believe that there is a very real moral problem involved, concerning which we have given all too little thought. It cannot be denied that human beings are being killed by bomb testing. It seems to me that it makes little difference whether we call the number large or small — the fact remains that individual human beings are being killed at random by our actions. Most of the persons who are killed live outside the United States, Great Britain and the U.S.S.R. All of us in the three nations involved must realize that we are establishing a precedent. And I frankly shudder at what the long-range consequences of that precedent might be for humanity as a whole.

But to return to the premises, I believe that the view that we can rely upon our ability to retaliate with devastating effectiveness to prevent all-out nuclear war and that we can, at the same time, wage "limited" nuclear war is fallacious. The major factor which negates this view, I believe, is that we will, in the not too-far-distant future, be confronted by a number of nations each of which possesses the ability to manufacture and use nuclear weapons.

It seems to me that the United States, England and the Soviet

Union, the nations which now possess nuclear capabilities in the military weapons field, could agree quite easily upon a plan for cessation of tests which could be monitored satisfactorily without jeopardizing other aspects of military security and which would effectively slow down, but not necessarily halt, the development of military nuclear technology in other parts of the world. Most of us would agree, I believe, that even a slowing down of progress in this area is something very much to be desired.

In my Minneapolis talk I suggested a possible sequence of steps which, if taken, would ease the present critical situation and which would create an atmosphere within which long-range goals could be pursued. These steps would involve first an agreement to stop all nuclear testing for a short period of from one to three years. During this interval an international group of scientists, knowledgeable in the nuclear-military technology field, would meet and draw up the specifications for a world-wide network of monitoring stations which would be built, operated and controlled by the United Nations. These stations might be placed, for example, at thousand-mile intervals over the earth's surface and they would be equipped with the most sensitive equipment available for detecting air and ground waves and radiation. Once it is agreed that such a network should be established, the agreement to stop testing could be placed upon a permanent basis, but with a peculiar but nevertheless extremely important loophole attached to the agreement.

It is argued by the proponents of our present policies that the nature of a democratic society is such that were we involved in an agreement of this sort we would not attempt to "bootleg" tests. But the Russians, it is argued, might well embark upon a program aimed at conducting tests in secret. It is also argued that our nuclear-military laboratories, such as Los Alamos and Livermore, would disintegrate while the Russians would be able to maintain their laboratories intact.

This difficulty could be circumvented, it seems to me, were we to agree that all tests which cannot be detected by the established monitoring system are legal. This would mean that the Russians and the Americans would be placed upon an equal footing and both nations could feel free to establish crash programs aimed at determining whether or not the severe testing restrictions might be circumvented.

I believe that it is possible for the Russians and the Americans to arrive at similar agreements in the satellite and missile fields. As a start, space outside the earth's atmosphere could be placed under United Nations jurisdiction and the functions of all satellites would be ascertained by inspection before being launched.

I would now like to carry the possible area of agreement between the United States and the Soviet Union one stage further. It is often argued that disarmament schemes are doomed to failure in part by the very nature of scientific discoveries. Dr. Edward Teller has stated, for example, that "scientific and technological developments have produced and will produce unexpected types of weapons," and he asks "how shall one check whether such weapons exist when the person who does the checking does not even know what he is looking for?"

I believe that this difficulty could be circumvented in part were we to establish, again under the United Nations, a well-endowed research and development program in military technology. The primary function of the research program would be to devise as many new and imaginative means of waging war as possible. The results of the research would be made available to all participating nations.

Such a program, were it established on a sufficiently large scale, could produce a desirable leveling effect and could aid immeasurably in laying the foundations for more general disarmament. At the very least it would enable all nations to keep track of a number of major advances in military technology. And it would provide invaluable background and experience which would enable the United Nations to approach the difficult problems of disarmament inspection realistically.

I would like to stress at this time that I do not for a moment believe that the measures which I have outlined thus far can give the world the security it needs. Such measures would simply represent a start down a long and difficult pathway. They could result in an easing of tensions. They would be agreements which could be kept because it would be to the advantage of all parties concerned to keep them. And above all they would buy that which the world needs most during this present critical period — time in which to solve the other longer-range and equally difficult problems of survival.

2.

Nuclear weapons, intercontinental missiles and satellites are, of course, serious threats to our security. But I would like to stress that I do not believe that the major threat to our security is from the outside. The major threat lies deep within ourselves. At the moment we are the richest nation on earth and we want to preserve our wealth. Beyond that we want to preserve a vaguely-defined freedom and an equally vaguely-defined way of life. Yet beyond this goal of preserving a nebulous status quo there lies only interminable emptiness. We have no real objectives. We have not the slightest idea what kind of a world we want to see. We refuse, really, to think about the future.

Americans were shocked last October when the Russians launched one thousand pounds of metal into space. Suddenly we were aware that a major new technological power had emerged half a world away. Why had we not been aware of this before? Certainly, the cold facts have been with us for a long time to be read and digested. But I am afraid that we were not aware for the very simple reason that we did not want to be aware. I am afraid that the latest model automobiles and the week's TV programs have been matters of considerably greater concern.

Following Sputnik there have been cries for blood and there have been numerous investigations. Who was to blame for our lag? The Democrats blamed the Republicans and the Republicans blamed the Democrats, and in a sense both placed valid charges. But to my knowledge no one publically placed the greater part of the blame squarely where it belongs — on the citizenry of our democracy. I fear that we have taken the attitude that we are willing to do everything we can for our country provided (1) it doesn't cost us money and (2) it doesn't interfere with our other activities. Give us satellites, yes! Give us more schools and teachers, yes! Give us research, yes! But let me have my new automobile first!

We live in a democracy in which the people are supposed to be sovereign. Yet the people have been notably unenthusiastic when it comes to accepting the obligations which are associated with sovereignty.

Why is it that even in a highly publicized Presidential election seldom do more than 60 per cent of the eligible electorate vote? Recently, in a school district election near my home, about 600 persons turned out to vote on a school bond issue. Nearly 20,000 eligible persons abstained from voting in that election.

Why is it that such a large proportion of our citizenry shirks jury duty? Why is it that a system of conscripting personnel for our armed forces is necessary if we are to be adequately protected in times of national emergency? Why is it that only about 2 per cent of our total personal income is paid out for schooling of all kinds, while we spend over 5 per cent on recreation alone?

Going still further, why is our suicide rate one of the highest in the world? Why in 1956 were nearly 100,000 youngsters under the age of fifteen and 350,000 under the age of twenty-one arrested? Why in the same year were over two and a half million major crimes committed? Why is the incidence of mental disorders increasing with such rapidity?

We own 50 per cent of the world's wealth, yet we account for little more than 6 per cent of its population. We own 29 per cent of the world's railroad mileage, 71 per cent of its automobiles and 52 per cent of its radios. We produce more food than we can eat. Yet in the midst of this material wealth, life somehow has lost purpose and meaning. We have become selfish, fat, conceited, soft and lazy. Where once we were doer's, we are now viewers. Where once we fought for freedom and democracy, we now take it for granted — or, even worse, ignore it.

It seems to me that we have a great deal of soul-searching to do and quite a few questions to ask ourselves. And the answers to these questions may well determine whether man continues to inhabit our planet.

Where lies America's destiny? What kind of a world do we want to leave behind for our children and for the generations which will follow them? What kind of a world do we, ourselves, want to inhabit? What outlooks and actions are necessary if we are to set our sights beyond those which our daily press, the world of advertising and our politicians set for us? What outlooks and actions are necessary if purpose and meaning are to be brought back into our lives?

In a recent article in *Foreign Affairs,* J. Robert Oppenheimer summed up our present situation very well when he said: "The United States has not developed an understanding of its purposes, its interests, its alternatives and plans for the future in any way adequate to the gravity of the problems that the country faces."

3.

Our world today is changing more rapidly than it has ever before changed in human history. The most notable characteristic of this change is the rapid spread of scientific-industrial civilization.

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Industrialization emerged in Western Europe and soon spread to the United States. In recent years it has spread to Japan and to the Soviet Union. We see it spreading today to China and to India. And barring a major nuclear war, the eventual spread of industrialization through the entire world would appear to be as inevitable as was the spread of agriculture, following its invention 7,000 years ago.

This rapid spread of the scientific-industrial revolution creates severe problems. In the first place the application of science and technology to agriculture makes it possible to increase substantially the quantities of food which can be grown. The establishment of modern transportation systems enables food to be moved from areas of surplus to areas of deficiency. The decrease in malnutrition which results from these factors has given rise to a great increase in the rate of world population growth. When we couple this with the fact that very simple and inexpensive methods for controlling epidemic and endemic diseases have come into widespread use, we see why it is that human populations are increasing as rapidly as they are. And we see further why it is that the *rate* of population increase is climbing rapidly as well. Before the scientific-industrial revolution, the population increased only very slowly. During the next few years the population of the world will climb at a rate corresponding to a doubling in numbers every 50 years. In a short time the doubling time may well be reduced to 35 years. There are now regions of the world where human numbers are doubling every 25 years.

A further problem is that as industrialization spreads, demands for raw materials such as ores of iron, copper and aluminum, coal and petroleum increase to fantastic levels. We can obtain some idea of the levels of demand which might be reached when we realize that if the world as a whole were to be industrialized to the per capita level which now prevails in the West, the combined output of all of the world's mines operating at present levels for one hundred years would be required to provide the necessary "capital" of iron, copper and other metals.

Superimposed upon this rapid increase in demand, we are faced by rapid decreases in the grade and the availability of raw materials. We must process ores of steadily decreasing quality; we must dig ever-deeper into the ground; we must apply more and more technology to the task of obtaining the raw materials we need for the perpetuation of our industrial civilization.

The tasks of keeping the complex machinery of industrial society functioning, of producing raw materials from the leanest of earth substances, of providing enough energy and power, of producing enough food for the rapidly-increasing numbers of mouths, of decreasing the rate of population growth — these tasks will necessitate our accumulating knowledge in the decades ahead at a rate which is far greater than our rate of accumulation today. Whether we like it or not, we have passed a major point-of-no-return and have become as dependent upon our science, technology and industry for the well-being of our civilization as we are dependent upon food for the well-being of our bodies.

It is possible for industrialization to spread quite rapidly. Steel production, for example, can be doubled every five years or thereabouts. But it is much more difficult to increase food production. In principle we know that it is possible at least to double the food productivity of India, for example, using known techniques which are in everyday use in the agriculturally advanced countries of the world. But in order to do this it is necessary to apply large quantities of fertilizers to the soil, to engage in elaborate programs of plant selection, to utilize a variety of modern pesticides and to construct vast irrigation systems.

Before one can apply fertilizers, it is necessary to manufacture them. This means that phosphate rock must be mined, sulfuric acid and nitrogen fixation plants must be built, chemical plants must be constructed. This in turn requires that there be steel plants, coal mines and transportation systems. In other words, food production cannot be greatly increased in a country such as India unless there is in existence a substantial degree of industrialization.

But increasing food production requires more than the mere existence of fertilizers and the like. It requires as well that the farmers change their ways of doing things. And as all of us know, it is difficult to change behavior patterns very rapidly. This was recognized by William James when he referred to habit as "the great flywheel of society."

The difficulties which are inherent in increasing food production are illustrated by a program which was well conceived and operated jointly by the Rockefeller Foundation and the Mexican government. As the result of prodigious effort the food production of Mexico was increased over a twenty-year period at an average rate of about 2 per cent per year. This apparently represents about the maximum that can be achieved within the framework of our existing techniques. And unfortunately, in the case of the Mexican experiment, by the time the twenty-year period had passed, the population had grown to the point that the gains were wiped out. The average person had no more food at the end of the program than he had had at the beginning.

We are faced, then, with the prospect that, in so far as food production is concerned, we must, like the Red Queen in *Alice in Wonderland,* run faster and faster in order to stand in the same place. Indeed, there seems to be every likelihood that the people of the world are going to become hungrier before they become better fed.

At the same time, as industrialization spreads, these hungry areas of the world will gain the power to wage modern war. And as the use of peaceful nuclear power spreads, as it will inevitably do, the capabilities of waging nuclear war will spread as well. Nuclear weapons in the hands of hungry people do not constitute, in my opinion, a cheerful prospect.

This situation will almost certainly result in strong desires to take what are believed to be "short-cuts." And when these people think of short-cuts they look to the Soviet Union. China has already adopted Communism. Other nations may well follow. And here we must remember that in our modern technological age the road toward totalitarianism is a one-way street — that no longer is the revolt of the masses possible — that once totalitarian power is gained, it can be maintained in the absence of help or disruption from the outside. The reason for this is that, as a result of our science and technology, enormously powerful tools of persuasion and coercion have come into existence and can be utilized with unprecedented effectiveness by the rulers of nations. And we must keep in mind that these tools will become even more powerful in the future — that we are just beginning to learn how to control men's minds using chemical, biological and psychological techniques.

It seems to me that a part of the tragedy of the present situation lies in the fact that these changes which are confronting us are taking place within the framework of world anarchy. A situation is rapidly developing in the world which will seriously jeopardize both security and individual freedom and over which, in the long run, we will be able to exert little control. The second part of the tragedy is that our science and our technology, if properly applied, could enable man to create a world in which all individuals have the opportunity of leading free and abundant lives. We know this to be a fact. It is not the lack of technical knowledge or of the earth's resources which are the major barriers to the evolution of such a work. The primary hindrance is man's apparent inability to devise those human institutions which can enable nation to get along with nation and man to get along with man and which can enable us to apply our technical knowledge at the rapid pace which the situation demands.

4.

It seems to me that the most important requisite for the survival, both of our nation and our freedom, is the formulation of long-range goals. The first of these goals involves the recognition that survival and world anarchy are incompatible, that whether we like it or not we must move toward a rule of world law or perish. We should heed the words of Alexander Hamilton when he asked "Why was government instituted at all?" And he answered, "Because the passions of men will not conform to the dictates of reason and justice without constraint." I believe that we should declare world law to be a goal, realizing fully the difficulties which lie in the path.

Our second objective should be to do everything possible to make the industrial transition in the presently underdeveloped areas of the world as smooth and as free from turmoil as possible. We should recognize that it is very much in the interest of our long-range security that starvation be eliminated in India, that her population be brought under control and that these things happen within the framework of a democratic government. In the long run this is even more important to our security and freedom than the development of the ultimate in intercontinental ballistics missiles.

Once we recognize that these long-range goals are truly requisites for survival, it becomes possible to formulate short-range goals and policies reasonably intelligently. I believe that high on the list of immediate objectives should be disarmament and control agreements, such as I have already discussed, under United Nations supervision and control. Equally high on the list should be the establishment, again under United Nations supervision and control, of a program of world development which is truly adequate.

I believe that our attempts thus far to aid the underdeveloped nations of the world have been in the main a failure. In the first place, we have spent too little. In the second place, that which we have spent has not been spent wisely. In the process we have succeeded in making more enemies than friends, and I believe that we have injured some countries more than we have helped them.

The standard of living of an area which is primarily agrarian in nature can be elevated rapidly only if a multiplicity of problems are attacked simultaneously. In the first place, *capital* is needed for the creation of production facilities for such materials as steel, aluminum, copper and chemicals and for the construction of power plants and transportation systems. Normally this capital would come from savings. But in practically all of the underdeveloped regions of the world, the savings rates are very low, with the result that capital can be accumulated only very slowly. And there is little hope that savings rates can be greatly increased in most of these regions to any really major extent in the near future. It seems to me that the only real hope for a dramatic change in this picture in the years ahead is for those nations which have high productive capacities and high standards of living to devise mechanisms whereby capital can be transferred at a substantial rate to the nations which need it. I believe that it is very much in the interest of the wealthy nations to provide a substantial fraction of the means which would enable the underdeveloped nations to start producing their own raw materials and goods on a scale which is commensurate with their needs.

The amount of capital which is needed in these areas is of staggering size. If, for example, we were to think in terms of providing adequate standards of living in the presently underdeveloped areas over a period of about 50 years, I estimate roughly that annual investments of the order of 20 to 25 billion dollars would be required. It seems to me that it is dubious that such expenditures would be possible unless some decrease in arms expenditures could be brought about simultaneously within the framework of controlled disarmament agreements.

I believe that the level of investment which is necessary could best be handled through a cooperative organization, preferably within the United Nations. Contributions to this organization could be made by the various member nations in proportion to their abilities to pay. Expenditures should not be made, in general, in proportion to the poverty of a given nation, but rather in proportion to the effectiveness which a given grant would have in expediting development. It seems to me that it would be better for money not to be given at all than for the effects to be negated by such factors as mismanagement, civil strife or an unseemingly large rate of population growth.

Science and technology can contribute enormously to problems of world development in a variety of ways. New techniques can be developed which can decrease capital investments per unit of output. There are numerous technical problems which are peculiar to underdeveloped countries and which could be solved by the concerted application of the techniques of western technology — problems which range from the processing of low-grade ores, to the development of new methods of birth control, to the industrial application of atomic energy.

In view of the potential applicability of the tools of western science and technology to the problems of development, I believe that we should consider establishing, again under the United Nations, a well-endowed research and development institute which would concentrate its efforts in these directions. Such an institute, which could draw upon the technical resources of all nations, could greatly increase the rate of development in the world and it could enable expenditures to be made judiciously and in such a way that maximum effect would be achieved.

At this point I would like to stress again that the rapid and smooth development of the underdeveloped nations is *essential* to the preservation and spread of individual freedom in the world. It seems clear to me that if we refrain from accepting this challenge on a scale which is truly commensurate with the need, we do so at our own peril.

5.

Returning home, it is obvious that the problems of survival which confront us today are complex and that those which will confront us tomorrow will be even more difficult to solve. These problems cannot be solved by narrow specialists or by robots, nor can they be solved by persons who live by platitudes and slogans. Indeed, they can only be solved by persons who possess a broad view of the world in which we live and of man's place within it — in short, by men and women who are truly well-educated, far above the level which is accepted today as perfection.

Of all the problems which now confront our nation, I believe that of education is the most important. The problem of securing some measure of nuclear disarmament is perhaps more urgent, in the sense that if a man's house is on fire he must put out the fire before he can live in the house. But in the long-run, education is the basic requisite for creating the understanding which is necessary if another outbreak of fire is to be prevented in the future.

We have got to face the fact that we are simply not sufficiently well-educated to survive in our modern world — that the savage in the jungle was far better equipped to survive in his world than we are in ours. The savage who is not familiar with his tools and weapons and who does not understand the habits of the plants and animals about him cannot survive for long. Similarly, we who live in the complex environment of industrial civilization must understand that civilization, the forces which operate upon it and the dangers which threaten it.

It seems to me that our *attitudes* toward education in America must be greatly changed if we are going to produce the kinds and numbers of truly well-educated persons we are going to need. Schools should be looked upon as institutions of learning and not as amusement centers or institutions for child care. Teachers should be looked upon as among the most precious members of our community. They should be respected fountains of knowledge and understanding — not simply overworked, underpaid babysitters. Children should be looked upon as individuals, some of whom are bright, and some of whom (let's face it) are stupid.

We should look upon the bright child as being our most treasured resource. Under no circumstances should we permit him to be held back by the stupid, or even by the average.

I believe that we should strip our curricula of frivolity and nonsense and eliminate from it those activities which could just as well be extracurricular or which should be learned in the home. We should load our students with just as much solid material as they can handle. And here, I believe, we have greatly underestimated the capacity of young people for learning. It seems to me that we could, if we wanted, give our above-average secondary-school students as good an education as they receive in most colleges today — which, after all, really is not very much.

If we are to have first-rate education, we must have first-rate teachers, which means that we must in some way persuade the very best of our young people to go into teaching. We need a national budget for education which is at least double the present one — which means that we should be willing to spend at least as much money on education as we are spending today on recreation.

Intimately connected with the problem of education, particularly at the higher levels, is the problem of accumulating new knowledge — of research. The tasks of keeping the complex machinery of industrial society functioning, of producing raw materials from the leanest of earth-substances, of providing enough energy and power, of producing enough food for the rapidly-increasing numbers of mouths, of decreasing the rate of population growth — these tasks will necessitate our accumulating knowledge in the decades ahead at a rate which is far greater than our rate of accumulation today. Whether we like it or not, we have passed a major point-of-no-return and have become completely dependent upon our science and our technology for our survival.

Even were we to ignore the technological demands which result from our need for adequate national defense, our needs for smoothly-functioning scientific research would increase rapidly in the future. In view of this, we must look upon forces which result in a lessening of intellectual productivity as threats which jeopardize our existence fully as much as any threat of an obvious military nature.

We should make a distinction at the outset between fundamental science, which is the pursuit of basic knowledge and understanding concerning the workings of nature, and technology, which is concerned primarily with the application of our basic knowledge and understanding to the solution of practical problems. To a certain extent technological developments can be dictated and controlled. If ample resources of fundamental knowledge are available, the more or less obvious applications of that knowledge can be pursued rapidly, even in a highly regimented totalitarian state. Technology thrived in Hitler's Germany; it thrived in Japan; and it is thriving today in the Soviet Union. Far from hindering technological developments, regimentation and control may even accelerate them, at least in special areas which are deemed important and which are more or less obvious, such as the areas of missiles or atomic bombs. For as long as the reservoir of basic knowledge is sufficiently large, technology can thrive either in the presence or absence of regimentation. But if basic knowledge is not accumulated sufficiently rapidly, technology will wither.

Basic knowledge and understanding cannot be pursued vigorously in an atmosphere of control, in part because the areas in which important new discoveries might be made are not predictable. No one can really say whether or not the area in which a given scientist is working is likely to yield important or significant results. Who could have predicted, for example, that a lone man, working early in this century on the seasonal cycle of the hedgehog, would uncover facts which would later be applied successfully in the treatment of cancer of the prostate?

The pursuit of basic research requires an atmosphere of freedom within which the individual scientist can operate. But as time has passed, although our numbers of scientists have increased rapidly, the constraints placed upon them by our society have also increased. One of the more important of these constraints involves the sources of funds.

Few universities or research institutes are sufficiently well-endowed to pay for any really large fraction of the research which is undertaken behind their walls. They must look for the support of their laboratories to private donors, to foundations, to industry and to the Government. These groups have the power of determining whether a given laboratory or a given research project will flourish or starve.

Of course individuals, industries and government agencies frequently have practical objectives and they tend to support research in their own particular areas of interest. As a result of these specialized interests there has been a tendency for scientists to drift toward those areas of activity where money is more readily available, thus producing a lopsided characteristic to university research efforts. There is a corresponding tendency for scientists to pursue the obvious, to tackle only those problems which the individual believes will be productive of quick results. After all, government contracts are usually on a year-to-year basis. And in science a year is a short time in which to produce enough results to justify the renewal of the contract.

We can ask: What cancer research foundation or government agency or industry would have supported the work to which I have referred on the seasonal cycle of the hedgehog if it had had the opportunity of doing so? I believe that, with the possible exception of the National Science Foundation, we would all be hard put to give an answer. And yet, from this work, great benefits to mankind were eventually forthcoming.

Certain government agencies are doing an admirable job attempting to overcome these difficulties. Private industries also are beginning to see the light and are contributing to university research on a no-strings-attached basis. But that which has been done thus far does not approach being enough.

The second constraint upon research today stems from the fact that scientists are individualists. They cannot work to best advantage in an atmosphere which is filled with FBI investigations, loyalty checks, loyalty oaths, public condemnation of their fellow scientists, pressures for conformity and accusations such as those which have been aired from time to time by both state and national investigating committees of various sorts. I don't suppose that we will ever really know quantitatively the extent to which American science has been damaged by such activities, but it is difficult to believe that the damage has not been substantial.

The third constraint upon research involves communication, which is the lifeblood of inquiry. The easier it is for scientists to talk with each other, the more rapidly does science advance. There are two major factors which inhibit the free exchange of ideas among scientists today. The first is the classification for security reasons of scientific work. The second involves restrictions which are placed upon the movements of scientists.

I personally believe that classification has permeated the scientific field to far too great an extent. It greatly impedes work, and in this respect it actually lessens our security. The most favorable thing that I can say about classification, as it is practiced today in many areas, is that it results in the employment of large numbers of people. But somehow I believe that those people could be doing more useful things.

The second aspect of communication involves discussions among scientists. Science is international in scope and rapid progress is dependent upon the exchange of ideas abroad as well as at home. And here, one of the more serious difficulties involves visits of foreign scientists to the United States. Largely as a result of our formidable restrictions for securing visas, most international conferences of scientists are held abroad. It is possible to hold such meetings in the United States, but it requires nerves of iron on the part of the organizers to do so — and one never knows until the day the conference opens who is really going to be there and who isn't.

I remember attending, three years ago, the meetings of the international geophysical union in Rome. The question of the location of the next meeting arose and invitations were extended by both Argentina and Canada. The Americans wanted to extend an invitation, but they appreciated the difficulties and refrained from doing so.

I had lunch with a Swiss friend of mine that day and he made a noteworthy suggestion. "Why couldn't we," he asked, "hold the conference on Ellis Island? There would be no visa restrictions. There would be ample accommodations. For recreation we could take sightseeing trips by boat around the island. And perhaps," he added ironically, "if it is a clear day we can see the Statue of Liberty in the distance."

Conclusions

To summarize, then, it seems to me that the primary requisites for survival are the following:

1. To obtain control and disarmament in the general areas of nuclear weapons and satellites.
2. To obtain a degree of disarmament with inspection and control in all areas of military technology.
3. To devise the means whereby the economic conditions of the world can be rapidly improved.
4. To work toward the ultimate goal of enforceable world law.
5. To improve our educational system so that all of our children emerge into the adult world really well-educated to the limits of their capacities to learn.
6. To provide the means whereby new knowledge can be accumulated at a considerably more rapid pace than it is being accumulated today, and to provide the atmosphere within which research can thrive.

I realize that this is a big order. But we should remember that the stakes are high and that the penalty for failure is the death of our civilization, our culture and our freedom.

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